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Stop Ruining Math! Reasons and Remedies for the Maladies of Mathematics Education¹

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Synopsis

Did you love math as a kid? Or was it ruined for you? Sadly, many people have had math ruined for them for various reasons. Some might say that it was because of not understanding what was going on, being bored in class, parental or societal pressure to achieve in math, not seeing a point in learning math, wrong amount of homework, grades, curriculum, physical concerns, mean teachers, or any number of things. This article delves into the many common reasons why math is ruined for so many kids, and offers solutions so that math can be enjoyable for everyone. Some of the solutions include societal shifts, some are things that math teachers can do in the classroom, some are ways parents can shift their attitudes towards math, therefore creating a healthier home culture surrounding math, and, lastly, some are ways that students can change the way they participate in math class to get the most out of it.

Lots of people have had math ruined for them for one reason or another. In our culture, math has almost become synonymous with torture. If you mention math in conversation, someone will probably say “ugh,” “I hate math,” or “I’m so bad at math.” So, is math ruination inevitable? Will math always be that subject that hardly anyone likes or thinks they are good at? Or is there hope? For many months I have surveyed people about how math was ruined for them. I’ve asked my friends and relatives, posted

¹This article is adapted from *How (Not) to Ruin Math* (tentative title, Natural Math LLC, forthcoming) coauthored by Rachel Steinig, a high school student, and her mother Rodi Steinig, an alternative math teacher.

on Facebook, and asked teachers and parents. Even though everyone's story was different, there were some common themes that ran throughout. Here I have grouped the responses into some broad categories. Just to be clear, these are not my opinions of what ruins math - these are the results of a survey of many people of all ages, education levels, and attitudes. So, while you read these responses, I want you to think about something — can we fix these problems? Or are they unsolvable? Or can we transform the way that math is taught so that everyone can enjoy it?



PROBLEM: CLASSES ABOVE/BELOW YOUR LEVEL

Having people of mixed math abilities in the same class, and having the class move too slow or too fast for you. Last year, I was in a regular math class, and then after a few weeks moved into honors. In my regular math class we only ever opened the textbook once in literally almost a month. I'm not kidding you. Then I switched into the honors class and when I walked into the room the teacher announced "Chapter One test today!" and I was forced to take it. I got a 55. The two classes were at such different levels. It was almost impossible to switch.

It's really important that kids are placed in the correct level of math class. It's a really big problem that kids are overwhelmed in classes that are above their level or bored to death in a classes that are too easy. I know that in some high schools, once a student gets placed in a certain "track" (remedial, regular, honors, AP) it's really hard to get changed to a different one. So if a student finds that their math class isn't right for them, it can be almost impossible to change. It's also a lot harder for kids to "move up a level" than to move down one. Sometimes the higher level math classes (honors/AP) move so much faster than the lower level classes that if a student stays in a lower level math class for, say, three weeks, and wants to move, the higher level class will already have covered so much information that it would be impossible for the kid to transfer into that class and get caught up.

Advice (students): Talk to the teacher about extra help or more advanced problems. The problem with this advice is that I wouldn't follow it, and I don't think my friends would either. Adults always try to tell kids to talk to their teachers for extra help or more advanced problems, and, sure, maybe I've asked a teacher for help once or twice, but they're pretty unapproachable, not to mention busy. And ask for harder problems? Never! School already

takes up enough of my life — there's no way that I would want to spend more time on homework, even if you paid me. Easy A all the way! Okay, time to be serious though. Once I was in a class that was way below my level, and I was bored to tears. So I got my mom to talk to the department head and convince him that I deserved to be in the honors geometry class instead of the regular one. So, in this case, I didn't ask for more homework — I asked to be switched to a class where the work was at an appropriate level for me. More work doesn't always equal more learning.

PROBLEM: TEACHER ATTITUDES

Teachers who make fun of and are unkind towards kids. In my research, I've found that a lot of people say that math was ruined for them because of "mean teachers." I was honestly surprised by this, because to be a teacher, you have to be a kind person who wants to make kids' lives better. What kind of system and working conditions could drive a benevolent and altruistic person to unkindness and a loss of temper? Obviously a terrible one. But, anyway, I'll tell the stories, with the preface that teachers in general are not mean, and actually want the best for their students.

Once in a math class, when a student did not understand a concept immediately, the teacher pulled up on the projector a site advertising where to get jobs as a truck driver (insinuating that the student was only intelligent enough to be a truck driver). The student was really embarrassed to be shamed in front of her peers. In another high school math class, when her high school students were whispering, the teacher screamed "Ladies and Gentlemen, we are not in kindergarten anymore, learn to control yourselves!" When my mom was in second grade, she was absent for a day. When she came back, her math teacher said "Go Stand in the Hall, Rodi!" (apparently a big punishment in those days). The teacher was mad at her because she was lost in class, quite understandably because she missed a day of instruction.

Now, why would a teacher do things like this? I posit that the main reason is because of the teacher's unsatisfactory working conditions. Often teachers are underpaid and have to teach overcrowded classrooms. They live in constant fear of being fired if their students don't get high enough test scores. They are forced to teach a government-mandated curriculum, even if they feel that it doesn't do its job. Because of the strict curriculum enforcements, they are required to cover a certain number of subjects in a year, and are often cramming to fit the overload of information into the one-hour-a-day (or

less) time slot they get. It's really stressful being a teacher, and no wonder they sometimes lose their tempers. It's not really their fault. Anyone who had such a hard job would yell sometimes. I honestly can't imagine being a public school teacher, because going to public school I've seen these kind, creative human beings who just want to make kids' lives better become depressed, unhappy, and tired-to-the-bone.² All over the world, people become teachers because they care and want to make a difference — not because they want to torture kids. It's so sad that they aren't treated with more love and respect.

Although most teachers are kind, to become a teacher you have to be okay with having a lot of power over students. Teachers have the power to make students do things against their will because it will benefit the students in the long run. Teachers enter the profession knowing that there is an imbalance of power and have the responsibility of wielding this power peacefully. The issue of whether teachers/administrators should have the right to decide what is best for every child and subsequently force them to do it seems to be taboo. Most people do think this is OK if it's for the kids' own good. Is there a flaw in this assumption? I don't know.

Teachers who aren't okay with saying "I don't know" or legitimately just don't know enough math. I think it's really important that if a teacher doesn't know an answer, they don't hide it and pretend to know. As a student, I totally understand that teachers are just human and don't know everything, and don't mind at all when they say "I don't know." In fact, I like it and I respect the teacher more for their honesty. It's important for kids to see that adults aren't perfect: the kids then feel better about themselves when they make mistakes of their own. I have had teachers who pretended they knew the answer to everything, and it really upset me and the other students. We felt as if the teachers didn't treat us with respect when they ignored our questions that they didn't know the answers to. Kids and teachers can form better personal relationships when they see that they both are just human. When teachers and kids feel more comfortable around each other, deeper learning can occur.

²In some other countries, teachers are highly respected and have great working conditions, because in those countries education is a priority (unlike here) and it's very competitive and hard to become a teacher, because it's such a respected profession (the equivalent of doctors and lawyers here).

So, why would a teacher be uncomfortable saying “I don’t know?” Probably because they are afraid that if they admit they don’t know everything about the subject they are teaching then the students won’t respect them. This may be true. This hasn’t been a problem in any of my classes, yet my school is atypical (the students are more academic than average), so I don’t know what it would be like in other schools. If these kind of situations are covered in teacher training, then a classroom culture of trust and respect can be cultivated between the students and the teacher.

Sadly, in a lot of elementary schools, to become a math teacher you don’t actually have to know that much math. Usually in elementary school one teacher teaches all of the core subjects. Some of these teachers actually have said that they don’t really understand what math is. That’s because they don’t have to know that much about math to be certified. This is a problem. Math is introduced to kids in elementary school and that’s when it’s the most important that they learn what math really is.

Advice (teachers): Talk to your students about what math really is. Most kids think that math is all about calculations and computations, and don’t know that math is really about discovering the underlying structure of things, about identifying patterns and breaking apparent patterns, about proof and certainty, about logic, and about beauty. We as humans have this need for order and predictability and math satisfies that part of us. Math is about so much more than calculating and using algorithms. What we learn in school is not beautiful, elegant math. In my opinion the biggest thing that needs to change in schools is for teachers to start teaching real math, not cookbook math.

PROBLEM: PARENT ATTITUDES

Parents wanting you to be a genius at math. Or forcing math down your throat. A lot of kids face parental pressure to achieve in math. Most parents want their kids to learn, perform well on tests, get good grades, and in the end get into good colleges. This is all good and normal — of course parents want the best for their kids. They want their kids to do well in school so that they can have easier lives with minimal amounts of hunger, poverty, and suffering. Parents love their kids, and these desires for success are just ways to express that love. The problems only start when parents pressure their kids to achieve so much that it actually harms the kids. When kids

are put under too much pressure to achieve, it can cause mental, emotional, and physical harm. Being under a lot of pressure can increase stress to an unhealthy level, and even cause physical health problems.² As a kid, I know that a lot of my peers are terrified of bringing home their report cards to their parents in fear that their parents will think their grades aren't "good enough." Some kids I know face punishments if their grades aren't high enough — no phone, no computer, no going out with friends. Some kids also get rewards if they get good grades — new phones, laptops, money, trips, cars, etc. One kid I know told me that "My parents promised to give me \$1,000 if I get straight As junior year." It's easy to get sucked into this whirlwind of rewards and punishments. I get jealous of my friends who get all these presents, because I want stuff. However, just the fact that parents give their kids rewards and punishments shows an attachment to the kids' grades and achievements, which can make the kids really stressed out.

This question of rewards and punishments can be really hard. Here's a scenario: a kid doesn't work hard in school and only works to get good grades if their parents offer rewards for good grades. The parents say that they want their child to get good grades in school, thus enabling the child to go to a good college, thus enabling him/her to get a "good" job that pays enough to supply him/her with the basic necessities and hopefully a life of material comfort. This scenario raises a lot of questions: Should the parents offer the kid rewards/punishments? What if the kid doesn't care about a life of material comfort and wants to follow his own dreams? Is the child old enough/mature enough to make this decision for herself? What if someday there weren't grades anymore? Then what would be used to determine who "succeeded" and who didn't? I'm not positing any answers. I think your answers to these questions really depend on your culture and values. These questions probably leave the realm of mathematics, but they are interesting to consider.

Parents posting grades/honor roll to Facebook. Social media can really increase the pressure on kids to succeed. I have friends whose parents take pictures of their report cards and post them on Facebook. This can be really embarrassing for the kids if they didn't get good grades. It's yet another mechanism to try to get kids to work hard and achieve. However, in my opinion, this tactic puts so much pressure on kids that they will probably achieve less than if they didn't have to be afraid of their parents publicizing their grades. The same idea with honor roll — I have seen many social media

statuses where parents said things like “Congratulations to my child, they made honor roll!” This can really increase stress and embarrassment for the kids. I once saw a parent post on Facebook a picture of their daughter with a nose ring, with the caption “This is what my straight ‘A+’ daughter wanted, so I let her get it.” When kids get too stressed out, or live with a constant fear of not performing well enough, they can become emotionally and physically hurt.³

Advice (parents): Try to pay attention to your child’s happiness, health, and stress levels and be conscious about whether your actions are contributing in an unhealthy way.

PROBLEM: STUDENT ATTITUDES

Students who do not ask questions in class. Very often in classes students do not speak up if they have questions. Sometimes, it’s because they don’t think it’s worth it when they could just look up the answer in their textbook later. Kids are burnt out from so much schooling that they don’t want to expend the energy to ask a question that they could answer for themselves later. This is true sometimes, but other times it’s because of fear.

Kids are afraid. First off, kids might be afraid to appear dumb in front of their peers and teachers. If a student speaks up to say “I don’t understand” they might be bullied or shamed because of it. Many times I have been approached by friends who said “I have a question, will you ask it for me?” Although it is a harsh reality to accept, bullying is a very real and huge problem in schools. I’m not really going to go into why bullying exists, but usually someone becomes a bully because they are not treated well and are not appreciated. Sadly, if someone is verbally or physically abused, they pass it on. And this passing on of abuse can often be in the form of embarrassing someone who doesn’t know the answer. Aside from just being worried about what their peers will think of them if they don’t understand something, kids are also worried about what their teacher will think of them.

³If you want to learn more about how academic pressure can negatively affect health and mental/emotional wellbeing, I would suggest the documentary *Race to Nowhere* and Vicki Abeles’ book *Beyond Measure*.

Also, kids don't want to be that one person who slows everyone down. Teachers already have to teach classes with kids of mixed abilities, and it is hard for the teacher to slow down to explain things to the confused student while simultaneously trying to engage the advanced child. Students are afraid to be that one confused student who is holding everyone back. The reality is, if a student speaks up with a question, it's very likely that other students have the same question and just were afraid to say something. In my physics class, I would often cross my fingers that someone would ask the question I had — I didn't want to ask it and hold back the rest of the class. To really create an environment conducive to learning, the students have to be able to ask questions without the fear of appearing dumb and/or a burden. Currently, fear is dominating many classrooms, but hopefully someday it will be eradicated.

Advice (students): Talk to your teacher, parent, or counselor about your fear of speaking up in class. Confession: my publisher told me I had to put some advice in here so I looked this up online. This is not what I would expect myself or any of my friends to actually do. Here's what I think the real advice should be: start out small. If you've never asked a question in a class because you've just been too afraid of appearing dumb or holding people back, maybe just try asking one question a week. Then, once you're comfortable doing that, try increasing it to two times a week, and so on. Sometimes the best way to conquer your fears is to confront them in a controlled, safe environment. Little by little, the more questions you ask, (hopefully) the more comfortable you'll become.

PROBLEM: REWARDS AND PUNISHMENTS

Using bribery as an incentive for kids to do math (The Problem With Grades). In almost all schools, there are tests. Little tests, big tests, hard tests, easy tests. Aside from just having regular tests in class, teachers have to prepare students to take standardized tests. So much classroom time is spent preparing for tests that the tests actually hinder the learning. Teachers have to spend a huge amount of time prepping kids for tests. Because of this tremendous focus on testing, some schools have basically announced that tests are more important than learning. Heck, even teachers get paid depending on how well their students score on tests! Schools get funding depending on how well their students score. Since schools have decided that tests matter so much, teachers have to find a way to make their students

want to take them and score well on them. Over time, grades have become a method of bribery to make kids want to take tests. If kids study and do well on a test, they get a reward — a good grade. If students do not perform well they don't get the reward. This system of grades hinders learning.

For example, if you had to choose between getting a “C” and really learning, or getting an “A” and not really learning, what would you choose? For me this is a hard question. I would like to believe that I would choose to get the “C” and actually learn, but I probably would choose to get the “A.” Sometimes teachers criticize students for only caring about grades, but can you really blame them? My little sister always tells me “All you ever talk about is grades!!” Students have been told their whole lives that if they get good grades they will get into a “good” college, get a “good” job, have a “good” life. They are told that if they do not study and perform well on tests they will have bad lives. This is a VERY strong message! *If you don't follow the rules and do as you are told, you will not have a good life.* Being told this day after day, year after year, students learn to obey. Students become complacent with the fact that, sure, maybe they aren't learning a whole lot, but at least they will have good lives (and remember that “good” really means “successful” and in our culture success is determined by achievement. This is an even larger problem — students aren't taught how to have emotionally and spiritually fulfilling lives; they are taught to have lives filled with achievement and material possession.) Students become afraid to rebel, to defy the system and try to learn. They are afraid to think for themselves. They become afraid of failure, an integral part of learning. They are afraid to ask questions. They are afraid to be creative and think outside of the box. They are afraid to live. This happens to me.

Advice (students): Try to remember that grades don't define you, try to find time to lead a balanced and healthy life, and if this is impossible, think about changing your educational situation.

PROBLEM: NO ACCESS TO SUFFICIENT EXPLANATION

Not understanding what you are learning in math class and having no one to explain it to you. In math classes, the students often have mixed abilities. For some, the class is too easy, and for some, the class is too hard. For those advanced students, there is usually enrichment: for example the teacher giving the kid extra problems, or maybe the kid studying on

their own. They can sometimes just do their own thing in math class and not bother anyone. However, for the struggling student, there isn't an easy "fix." They can't just do their own thing in math class because they don't understand what's going on. Now, if you are a student who is struggling in class, what can you do? Here are the usual answers: go ask the teacher for help, go to tutoring, or ask your parents. These are all great answers except for the times when they aren't. Some of my friends tell me "I am SO jealous of you! My parents don't speak English so they can't help me with my homework." There are a lot of situations when the resources simply aren't available. Teachers are often overworked and do not have time to help a struggling student. In some schools tutoring isn't offered and the student's family can't afford to hire a tutor. As for the suggestion of "going to your parents," a lot of parents don't know enough math to tutor their child, let alone understand it themselves. I hope that someday all these resources will be available to struggling students, but the sad truth is that right now they are not.

Advice (students/parents): Try to find someone who could help you — maybe a parent, a teacher, a friend, a counselor, or anyone else. For example, if your math teacher can't help you, try approaching one of your math teachers from a previous year for help. If your parents can't help you, try talking to a friend who has a high grade in the class. If all else fails, or actually you should probably do this first, pay a visit to Professor YouTube. Say you don't understand completing the square. There are plenty of people who explain it well online. I recommend James Tanton for videos, and <http://www.mathisfun.com> for clear and concise written explanations.

PROBLEM: CONTENT AND CURRICULUM

When kids don't see a point in learning math. Many kids I have talked to say "I'm not going to use math in my adult life, so why do I have to learn it? It's not like I'm going to be a mathematician or scientist or something." These kids raise a valid point. In math classes where practical applications are introduced, they are usually NOT things that would actually come up in real life. For example, the ever popular "Two trains left the station..." Oy vey. Most people are not going to end up in a situation where they need to calculate train speeds! Other than the basics, most people do not end up using the math that they learned in school when they are adults. Of course, the exception is if you go into a math-heavy field, such as engineering. So

then, why do kids have to learn math? If math is taught right, a certain way of thinking, “mathematical thinking,” can be learned. Mathematical thinking is the way you have to think when solving math problems. This type of analytical thinking can be used all throughout your life - not just for math. It’s not like you need to have memorized a certain formula to succeed in life - I mean, that’s what the internet is for! The problem is that today in schools mathematical thinking is not always taught. If algorithms are given to students, if students only are required to memorize and not think, then mathematical thinking will never develop. The more you make mistakes, the more your brain grows.⁴ If you are only given easy problems with algorithms for how to solve them, then your brain will never grow and your analytical thinking skills will not develop. Once schools forget algorithms, forget speed (faster does not equal better!), and forget memorization, students will finally be able to struggle and really grow their brains in meaningful ways that will serve them their entire lives.

When I was little, I always thought that math was so boring. I hated basic operations, fractions, decimals, percents, and basic algebra. I would much rather have been reading a book or playing outside. I thought that math was rote, memorization-based, and non-creative. I liked to do things where I could use my imagination and creativity and think up new possibilities. Math seemed to lack everything that I loved.

When I started going to Math Circles, everything changed. In Math Circles we talked about the problems and worked together. We wrote lists of our questions, conjectures, and assumptions. It was all about trying to do things in new ways, using our creativity to come up with as many answers as possible, and having fun. At first I was dubious whether what we were doing was really math. “It can’t be math, it’s fun!” I told my mom. We watched videos and made art. We moved our bodies and danced. We read books about mathematicians and learned all about their personal lives. We asked deep questions -

“Was math invented or discovered?”

⁴See Jo Boaler’s online course *EDUC115-S How To Learn Math: for Students*, taught via Stanford Online. Here is a link: <https://lagunita.stanford.edu/courses/Education/EDUC115-S/Spring2014/about>.

“Is math a tool? Or an art?”

“If you won’t use math in your career, is there even a point to learning it?”

“Are there any real practical applications of math?”

“But does it matter if there are practical applications? If it’s an art, why does it matter?”

“What is a line?”

“What is a point?”

And so on. We were encouraged to look at things from different perspectives and to think outside of the box. My thinking was revolutionized. All of my assumptions about math had been disproved. Something that I hated grew into something that I loved.

This issue of how real math requires creativity and an open mind ties back to the issue of school not teaching kids real math. Once schools teach real math, then naturally the lessons will be more creative because math is all about thinking about things from different perspectives.

I want math to be like this for all kids. It’s so magical when you discover something new that you love to do. I want to revolutionize the way that math is taught so that kids can learn and love math, that way that my mom did for me. If math can be taught through multiple mediums (videos, books, art projects, nature, movement, video games, puzzles and manipulatives, old fashioned pencil and paper, etc.), taught in an environment that encourages originality and creativity, and doesn’t have an emphasis on testing and grades, math will truly become something that kids will love, learn deeply, and develop a passion for.

Advice (parents): If your child isn’t being taught interesting math in school, then, if possible, you can help your child learn to love math by using resources outside of the classroom. For example, there are a lot of video and computer games that teach mathematical thinking. Video games have a big thing going for them — they are interactive. Interactive learning is way more fun for kids and more conducive to learning than traditional education. Kids can learn way better when playing with something than with a teacher telling them whether or not their answer is correct on a test. A video game

tells you automatically if what you are doing is right or not — and if it's wrong, you can easily correct yourself. It teaches students perseverance and doesn't punish them when they are wrong. It will reward work ethic instead of "intelligence." Studies actually show that if students are praised by being called "smart," they will actually be afraid to mess up, but if they are praised for being "hardworking," they will continue to work hard. Video games will make the kids who work harder succeed and boost their self-esteem while at it. Oh, and, of course, if you have the chance, go to a math circle.

PROBLEM: WRONG AMOUNT OF HOMEWORK

Having too little or (gasp!) too much homework. Your brain works like a muscle — the more you use it, the stronger it gets. So embrace the struggle! Working on hard math problems may seem frustrating and impossible, but in the long run your brain will get stronger and you will get better at math. That's why homework is really important — it's essential that you practice mathematical ways of thinking so that you can remember how to solve certain problems. The more you do math, the more analytical thinking skills you will develop. But, on the other hand, too much homework is never fun. If you are coerced into doing math, and are forced to do it all the time, then any sane person would get a little bored of it after a while. Snooze snooze. I have to admit that I've fallen asleep my fair share of times while doing homework - it just gets so boring! That's why it's important to find the right balance of having enough time to practice essential math concepts, yet also not spending so much time on math that you grow to hate it. Some studies have actually reported that there is an "optimal" amount of homework for each age — where more than that amount of time is too much and less is too little. It's hard for teachers to hit that sweet spot because of how much content they have to cover in a year — it's easy for them to assign too much, especially in advanced classes. However, assigning too little is also a problem and should be avoided.

OK, here's a confession: I never memorized my times tables. I tried, I really did — I did some computer games where you had to navigate your way past trolls and things by correctly answering math questions ("What's 5 times 9?"). But honestly, I just didn't care enough. I always told my mom "I don't want to practice my times tables!" I only ever needed about half of them in the math I was doing, so why bother learning the rest? Throughout the years I've ended up learning most of them out of necessity, and it's been

fine. Inquiry-based learning really does work — sure, I didn't learn my times tables when I was younger, but I learned them when I needed to, so why does it matter? When a student really needs to learn an essential math concept, if they want to learn it and put in enough hours, then they can do it. Sure, some sweat and struggle will be involved, but in the end perseverance wins.

Advice (teachers): Research the optimal amount of homework for each age and try to assign accordingly. However, I know that sometimes this can be impossible — a lot of the time you are under pressure to cover the whole curriculum, finish the textbook, and follow the Common Core Standards, and have to assign a certain amount of homework so that by the end of the year your students learn whatever they're required to. If you would like to change the amount of homework that you need to assign, but are not allowed to, encourage your administrators to see the film *Race to Nowhere*, which documents the ill effects of the wrong amount of homework.

PROBLEM: PHYSICAL CONCERNS

Being in an environment that is not conducive to learning. You know how some classrooms seem like the ugliest things you have ever seen and no one in their right mind should have to learn in there? If that's what you are thinking, then you are 100% right. Some environments are just no good for learning. When I was little, I always remarked, "Mommy, that looks like a prison!" when I walked past my neighborhood public elementary school. If your math class is in a dingy classroom filled with mouse droppings and no light filtering in, then you might have the desire to fall asleep. Especially if all of the desks are facing one direction, so you can't even see most of the kids in your class. Math is about discussion and cooperation! The best way to learn math is to work on it collaboratively. This is completely impossible if you don't even know the names of half the kids in your class. One year in my math class, all of the desks faced in one direction. I hardly knew anyone in the class. Sometimes when my teacher would call on someone, the rest of the class would exclaim "Who's that? There's a _____ in our class?!" If teachers want their students to be alert and enthusiastic, it helps to open up the windows, let some light into the room, move the desks around so that the kids can get to know each other, and offer some variety in learning environment.

Of course I'm being idealistic; teachers are under tremendous stress and pressure to just make sure that all of the students pass and might not have the time or energy to make these changes. But, if possible, it would be wonderful if sometimes classes could be held outdoors. Students with more views of nature outside of their windows actually score higher on exams. We as humans are connected to the earth, and when seeing nature we are calmed and our stress levels go down. All of my teachers throughout my years of school have closed the shades and turned on all of the lights. Maybe, if it's feasible, it would be nice to have some natural light sometimes. The benefits will be enormous. Lastly, let students move their bodies! It's not healthy for anyone to sit still the whole day. Moving our bodies provides us with energy and makes us more alert, which in turn will help us understand math better.

It's really hard for some kids to sit still at school all day. This makes sense because studies actually show that it's unhealthy and unnatural to sit still all day (totally freaked me out - I spend so much time sitting at the computer). Kids learn best when they can move their bodies. Actually it's really easy to integrate movement into math class. It's also really important to integrate cooperation into math classes too, because math is best learned cooperatively! In math circles (collaborative math workshops), we work on problems together and discover way more things than if we were solving them on our own. Everyone has different skills and knowledge. When we work together we have a lot more fun and learn a lot more than working alone. In the classroom, even if teachers aren't able to make their lessons cooperative, there are lots of easy ways to configure the classroom to make it more conducive to cooperation and movement.

Now, for math and movement: A wonderful way to teach math is through movement. Math and dance can be easily integrated. According to Malke Rosenfeld's website *Math in Your Feet* (<http://www.mathinyourfeet.com>), topics such as "congruence, symmetry, transformation, angles and degrees, attributes, categorical variables, manipulation and analysis of complex patterns, mapping on a coordinate grid, as well as deep experience with mathematical practices and problem solving" can be taught through dance. Dancing is a lot of fun and gets kids' bodies moving while they simultaneously learn math. No instructional time is lost. What better way to add more movement than by adding it to traditional classes?

In terms of cooperation and room configuration, moving the desks around can make a huge difference. This change of scene can make students stay more alert in class as well as get to know each other better. A lot of times all of the desks are facing in one direction and the kids never really get to know each other. Math is way more fun for students when they can work together on problems - math should be about cooperation, not competition. In the real world, mathematicians cooperate instead of compete. School should be set up like the real world. Changing the seating arrangements throughout the year can help. Another way to help is for students to be told to work together on math problems instead of on their own. In my Geometry class the teacher told us to work on our homework together in class - and it was a great system. If I didn't understand something, I could just ask the people I was working with to help me out and vice versa. This eradicates the problem of kids being too afraid to ask their teachers questions — they can just ask their friends!

A fun arrangement of desks is to arrange them in a circle, if the classroom is big enough for that. This really encourages discussion. You can see the faces of everyone in the class and this alone can make the atmosphere more cooperative and less scary. This only works if you have a small enough class. But, if possible, this should totally be done because it rewards students with a much more interactive learning experience!

Advice (teachers): Try to move the desks around and let some fresh air into the classroom.

PROBLEM: FEAR

Fear is an overarching theme here. A parent told my mom that if there was such a thing as “Math Therapy,” she would send her daughter. I was curious, so I googled “Math Therapy” and it’s actually a thing.⁵

There is so much fear surrounding math. Students are afraid that they will not know the answer, that they will be shamed in front of their peers. Students are afraid to be wrong and to make mistakes because this means getting bad grades. Parents are afraid that their kids will not do well in math

⁵**Editor’s note:** Readers might enjoy Gary Stogsdill’s article “A Math Therapy Exercise” (*Journal of Humanistic Mathematics*, Volume 3 Issue 2 (July 2013), pages 121–126. Available at: <http://scholarship.claremont.edu/jhm/vol3/iss2/9>).

and will fail, which could result in not getting into college and not having a successful life. Teachers are afraid that their students will not learn enough to truly understand math. Teachers are also afraid that they will lose their jobs, that their students will not score high enough on standardized tests, and that the resources will drain out and their students will not be given the attention that they deserve.

With all of this fear, it is no wonder that so many people hate math and are angry that they have to learn it. Underneath anger is often fear, and that is the case here: people are afraid that they will not be good at math and this fear is manifested as anger. I want to help people become less afraid of math. Math can be beautiful and really fun to learn and do, if taught in the right way. I hope that we can get rid of all these problems, these “Things that ruin math” and make math fun. To do this, though, we need to get rid of the fear. The fear and the things that ruin math are connected. For example, a lot of this fear about “not being good enough” at math stems from the fact that we are scored on our math performance; we are judged. If grades are taken away, hopefully some of this fear about “not being good enough” will also go away. Math is wonderful for so many reasons and I hope that soon everyone, young and old, will be able to see this.

Advice (teachers/administrators): educate people about what math really is.



Once I had a math teacher who truly taught an amazing class. When I walked into the room, there were no desks and instead pillows, cushions, and beanbags all over the floor. There were lots of potted plants in the classroom and outside the floor-to-ceiling windows we had a view of the woods behind the school. We started the class (there were ten students) sitting down on the ground in a circle and, after doing a short mindfulness meditation, had a discussion about what we thought math was and if anyone had ever told us what it was. Then, on white boards we wrote down the different definitions and our questions. We talked about if any of us had math anxiety (we all did) and talked about why this was and how to reverse it. Then our teacher talked a bit about what math really is and how it actually can be super fun. For the first unit of class we went out into the woods and looked for the Fibonacci sequence in nature. Then, we collected examples and brought them back to the classroom to create an art exhibit. We also went to the art studios in the

school and embellished our findings in any way we wanted while also creating new art pieces inspired by the natural world and Fibonacci numbers. Once we created all of our art we hung it all around school and also donated some to a nursing home.

The next unit it was time for food. We spent all week making delicious edibles so that on the last day of the week we could have a big feast. We learned all about fractions and multiplication by using single recipes to make food for the whole class (how much can one person really eat and how many times do we have to multiply the recipe to make enough food?) and also dealing with limiting reactants (we only have $4 \frac{3}{7}$ cups of flour, but we needed 6. How can we adjust the rest of the ingredients to make our recipe balanced?). We had tons of fun making things like lasagna, pizza, brownies, vegetable soup, salad, pumpkin pie, garlic bread, lemonade, hot chocolate, samosas, pad thai, and many more things. By the end of the unit we had stocked all of the school fridges with delectables and had a delicious feast with only one kid throwing up from eating too much (Jimmy, and it was the cherry pie that did him in).

The next unit we spent in the school gym dancing. We had professional dancers come in to teach us to dance and also experts in the field of integrating math and dance. We learned all about concepts like symmetry, geometric shapes, patterns, multiplication and division, area, volume, and many more. We created our own dance routines and at the end of the unit we put on a huge dance show for the school.

Another unit we spent learning about math history through reading. Our classroom had a huge collection of books about famous mathematicians and famous unsolved math problems and we spend weeks just going to class every day, finding a comfy spot, and curling up with a book. After we spent a while reading we made a list of unsolved math problems that we wanted to try (we all secretly wanted to become famous for solving these super hard math problems). Then we spent awhile trying to solve them.

Anyway, you get the idea. We learned math in the real world. We went on numerous field trips to a variety of different places and saw how math is being used in the real world. We learned through exploring and following our interests in a learning environment that was all about cooperation. I learned more in that class than in all of my other classes combined.

OK, confession time: none of this ever happened. I totally made it all up! Could you tell? I don't know if there were any dead giveaways, except for maybe the fact that I've mentioned how I never liked math class before. I've actually never been in a math class that's even remotely like this one. But, I wanted to make up what I thought would be the ideal math class. One that I would actually want to go to. This class taught math in many ways, because people learn math in many ways. Something different works for everyone. This teacher recognized that everyone is intelligent in a different way and has their own insights to add to the class. Besides, who wouldn't go to this class — it sounds so fun! Who wouldn't want to play in the woods, create art, cook and eat food, learn how to dance, read a ton, and go on field trips all in one class?!

CAN WE FIX THESE PROBLEMS WITH MATH CLASS?

Remember, way back at the beginning of this article, when I asked you to think about whether we can actually fix the problems in math education? Well, it's time to talk. Obviously, there are a lot of problems in math education. It's quite easy to count on one hand the number of things that can be improved. I admit it, it's way easier to focus on the problems than the solutions. But just hear me out: the fact that we can identify the things that need to be fixed in math education means that we can fix them. If we know what's being done wrong, we can make it right.

And, believe it or not, there are ways in which math is being taught that make it fun and rewarding, and there are inspiring individuals working to reform math education every day. For example, look at the hypothetical math class I made up. That sounded pretty fun. And hey, if it didn't seem fun to you, don't sweat it — there are many ways to teach math, and they all work for a minority of people. There isn't one "magic" or "right" way to do it that works for everyone. It would be awesome if teachers explored teaching math in tons of different ways, and some are already doing this, which is super awesome! If math is taught differently, kids can grow to love it and use it to discover deep truths about the world around them.

We can change the way math is taught for the better. We can create a revolution. A revolution so that everyone knows what math really is. So that everyone is intellectually stimulated in math class. So that everyone has fun learning math. So that no one is afraid of math any more.

Let's work together. Let's change the way children are taught. Let's bring back the joy into mathematics. Let's eradicate fear and foster creativity.

And, by doing this, let's change the world.